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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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Haining Yang

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01/11/2005

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EXAMINER

HOGANS, DAVID L

ART UNIT

PAPER NUMBER

2813

DATE MAILED: 01/11/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/932,236

Applicant(s)

YANG, HAINING

Examiner

David L. Hogans

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 08 October 2004.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 55-62, 64, 65 and 70 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 55-57, 59-61, 64 and 65 is/are rejected.
- 7) ☒ Claim(s) 58, 62 and 70 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 16 August 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>10-08-04</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

This Office Action is in response to the Amendment filed on October 8, 2004.

Status of Claims

1. Claims 55-62 and 64-65 are pending. Claim 70 is newly added. Claims 1-54, 63 and 66-69 are cancelled.

Claim Rejections - 35 USC § 112

The rejection of Claims 55-59 under 35 U.S.C. 112, first paragraph, is withdrawn pursuant to Applicant's remarks filed on October 8, 2004.

Claim Rejections - 35 USC § 102

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 55-59 are rejected under 35 U.S.C. 102(e) as being anticipated by 6,515,843 to Nakabayashi et al.

In reference to Claim 55, Nakabayashi et al. teaches:

- providing a semiconductor substrate; (See Figures 18, 19, 26, 27 and 32-44 and columns 21-35 lines 20-67)
- forming a first conductive material over the substrate, the first conductive material comprising one or more of TiN, WN, TaN, elemental Ta, and elemental Ti; (See Figures 18, 19, 26, 27 and 32-44 and columns 21-35 lines 20-67) and

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- depositing a second conductive material physically against the first conductive material, the second conductive material consisting essentially of a metal and being different than the first conductive material, wherein the depositing comprises: (See Figures 18, 19, 26, 27 and 32-44 and columns 21-35 lines 20-67)
- providing a metallo-organic precursor proximate the first conductive material, wherein the metallo-organic precursor comprises the metal and carbon; (See Figures 18, 19, 26, 27 and 32-44 and columns 21-35 lines 20-67) and
- exposing the precursor to a reducing atmosphere (hydrogen) to release the metal from the precursor to form the second conductive material physically against the first conductive material without an insulative composition between the first and second conductive materials (See Figures 18, 19, 26, 27 and 32-44 and columns 21-35 lines 20-67)

In reference to Claim 56, Nakabayashi et al. teaches:

- forming an insulative material over the substrate, wherein the insulative material comprises sidewalls defining an opening extending to the substrate in at least one cross-section, and wherein the forming the first conductive material comprises forming the first conductive material within the opening (See Figures 18, 19, 26, 27 and 32-44 and columns 21-35 lines 20-67 – noting Figure 41)

In reference to Claim 57, Nakabayahi et al. teaches:

- etching the second conductive material into a rectangular block, wherein the block comprises a sidewall aligned vertically with one of the sidewalls of the insulative material in at least the one cross-section (See Figures 18, 19, 26, 27 and 32-44 and columns 21-35 lines 20-67)

3. Claims 60-61 and 64 are rejected under 35 U.S.C. 102(e) as being anticipated by 6,355,492 to Tanaka et al.

In reference to Claim 60, Tanaka et al. teaches:

- providing a semiconductor substrate (10) having tungsten-comprising layer thereover (19); (See Figures 7-10 and columns 12-14 lines 20-65)
- exposing one or more metallo-organic precursors to a reducing atmosphere to release metal from at least one of said precursors, the one or more precursors comprising one or more of ruthenium, rhodium, iridium, cobalt, palladium and nickel; (See Figures 7-10 and columns 12-14 lines 20-65) and
- depositing the released metal (22A) over the tungsten-comprising layer to form a conductive material on the tungsten-comprising layer (See Figures 7-10 and columns 12-14 lines 20-65)

The Examiner notes that Merriam Webster's Collegiate Dictionary (tenth edition) defines on as "a function word used to indicate position in close proximity with". The Examiner notes that the released metal is on the tungsten comprising layer.

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In reference to Claim 61, Tanaka et al. teaches:

- wherein the tungsten-comprising layer comprises an upper surface of elemental tungsten (See Figures 7-10 and columns 12-14 lines 20-65)

In reference to Claim 64, Hicks et al. teaches:

- wherein tricarbonyl-cyclohexadiene ruthenium is comprised by said one or more precursors (See Figures 7-10 and columns 12-14 lines 20-65)

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 55-59 are rejected under 35 U.S.C. 103(a) as being unpatentable over 6,074,945 to Vaartstra et al. (hereinafter Vaartstra '945) in view of 6,197,628 to Vaartstra et al. (hereinafter Vaartstra '628)

Claim 55

Vaartstra '945 teaches providing a semiconductor substrate; forming a first conductive material over the substrate, the first conductive material comprising one or more of TiN, WN, TaN, elemental Ta, elemental Ti and elemental W (noting column 6 lines 5-25); and depositing a second conductive material consisting essentially of a

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metal and being different than the first conductive material, wherein the depositing comprises: providing a metallo-organic precursor proximate the first conductive material, wherein the metallo-organic precursor comprises the metal and carbon; and exposing the precursor to a reducing atmosphere to release the metal from the precursor to form the second conductive material. (See Figure 1 and columns 1-6 lines 40-60)

Vaartstra '945 fails to explicitly teach wherein the second conductive material is formed physically against the first conductive material without an insulative composition between the first and second conductive materials.

However, Vaartstra '628, in Figure 6 and column 10 lines 20-35, teaches wherein a second conductive material is formed physically against the first conductive material without an insulative composition between the first and second conductive materials.

It would have been obvious to one of ordinary skill in the art to modify Vaartstra '945 by incorporating a second conductive material formed physically against a first conductive material without an insulative composition between the first and second conductive materials, as taught by Vaartstra '628, to provide an electrical connection to a substrate that prevents the migration of silicon into the metallic layers, thereby preventing destruction of the contact.

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Claim 56

Incorporating all arguments of Claim 55 and noting that Vaartstra '945, in column 3 lines 55-65, teaches forming an insulative layer over the substrate, wherein the insulative material comprises sidewalls defining an opening extending to the substrate in at least one cross-section, but Vaartstra '945 fails to explicitly teach wherein forming the first conductive material comprises forming the first conductive material within the opening.

However, Vaartstra '628, in Figure 6 and column 10 lines 20-35, teaches wherein forming the first conductive material (285) comprises forming the first conductive material within the opening (259).

It would have been obvious to one of ordinary skill in the art to modify Vaartstra '945 by incorporating forming the first conductive material within the opening, as taught by Vaartstra '628, to provide a diffusion barrier for prevention of silicon migration, which can cause destruction of the contact.

Claim 57

Incorporating all arguments of Claims 55 and 56 and noting that Vaartstra '945 fails to explicitly teach etching the second conductive material into a rectangular block, wherein the block comprises a sidewall aligned vertically with one of the sidewalls of the insulative material in at least the one cross-section.

However, Vaartstra '628, in Figure 6 and column 10 lines 20-35, teaches etching the second conductive material into a rectangular block, wherein the block comprises a sidewall aligned vertically with one of the sidewalls of the insulative material in at least the one cross-section.

It would have been obvious to one of ordinary skill in the art to modify Vaartstra '945 by incorporating etching the second conductive material into a rectangular block, wherein the block comprises a sidewall aligned vertically with one of the sidewalls of the insulative material in at least the one cross-section, as taught by Vaartstra '628, to provide for local and global planarization, which improves the quality of follow-on-process steps, such as lithography.

Claim 59

Incorporating all arguments of Claim 55 and noting that Vaartstra '945 teaches wherein the metallo-organic precursor consists essentially of tricarbonyl-cyclohexadiene ruthenium; the reducing atmosphere consists essentially of ammonia; and the second conductive material having a thickness of about 800 Å (noting that deposition rates can be 100 Å/min).

Although Vaartstra '945 does not teach a second conductive layer with a thickness of 450 Å, it would have been obvious to one having ordinary skill in the art at

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the time the invention was made to optimize the deposited layers thickness, as the goal of device electronics is to become smaller, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233 (CCPA 1955)

Finally, the specification contains no disclosure of either the critical nature of the claimed process (i.e. – the second conductive layer having a thickness of 450 Å) or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen limitations or upon another variable recited in a claim, the Applicant must show that the chosen limitations are critical. *In re Woodruff*, 919 F.2d 1575, 1578 (Fed. Cir. 1990)

6. Claim 65 is rejected under 35 U.S.C. 103(a) as being unpatentable over 6,355,492 to Tanaka et al. in view of 6,074,945 to Vaartstra et al.

Incorporating all arguments of Claim 60 and noting that Tanaka et al. fails to explicitly teach wherein the reducing atmosphere comprises ammonia.

However, Vaartstra et al., in column 3 lines 40-50, teaches wherein the reducing atmosphere is comprised by ammonia.

It would have been obvious to one of ordinary skill in the art to modify Tanaka et al. by incorporating a reducing atmosphere comprised by ammonia, as taught by Vaartstra et al., to provide a reactive complex that is favorably deposited on the substrate, and to additionally regulate the uniformity of deposition across the substrate.

Response to Arguments

7. Applicant's arguments filed October 8, 2004, have been fully considered but they are not persuasive. Specifically, the Examiner only refers to the arguments concerning Vaarstra '945 and Vaarstra '628. With regards to these references and Claims 55-57 and 59 the Applicant proffers that Figure 6 of Vaarstra '628 does not teach a layer of TiN. The Examiner kindly refers Applicant to column 10 lines 20-30, which teaches that TiN may be formed within the opening (259).

8. Finally, Applicant argues that Vaarstra '628 teaches away from Vaarstra '945 because it uses an inert gas to deposit the precursor. The Examiner notes that Vaarstra '628 need not teach depositing the precursor with a reducing gas because Vaarstra '945 already taught the concept.

Allowable Subject Matter

9. Claims 58, 62 and 70 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

10. The following is a statement of reasons for the indication of allowable subject matter.

As to Claims 58 and 70, the prior art of record fails to teach or suggest, in combination with the other claimed elements, etching the second conductive material into a rectangular block, wherein the sidewalls of the block are aligned vertically between the sidewalls defining the opening in at least the one cross-section.

As to Claim 62, the prior art of record fails to teach or suggest, in combination with the other claimed elements, wherein the tungsten-comprising layer comprises an upper surface of elemental tungsten and wherein the conductive material is formed physically against the upper surface.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to David L. Hogans whose telephone number is (571) 272-1691. The examiner can normally be reached on M-F (7:30-4:30).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead Jr. can be reached on (571) 272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

DA
DH

Craig A. Thompson
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PRIMARY EXAMINER